

Application No. 09/391,943
Response to Office Action

Customer No. 01933

Listing of Claims:

Claims 1-69 (Canceled).

70. (New) An image processing apparatus for processing an image of an object, said apparatus comprising:

a three-dimensional form recognizing unit which recognizes a three-dimensional form of the object by using image data of the object taken by an image input apparatus, and which outputs object three-dimensional form information regarding the three-dimensional form of the object;

a specular reflecting component separating unit which separates a specular reflecting component from light reflected from the object in the image of the object, and which then outputs the specular reflecting component;

an interpolating and composing unit which subjects the image data of the object taken by the image input apparatus to interpolation and composition processing to thereby obtain an image of the object, and which then outputs the obtained image of the object; and

an observing light position changing unit which converts the image data of the object taken by the image input apparatus into an acquired image in which a direction of illuminating light for

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20 illuminating the object is changed, by using the three-
dimensional form information, the specular reflecting component
and the image obtained by the interpolation and composition
processing, based on a difference between (i) photographing
environment information comprising geometric information on a
25 light source for illuminating the object when the object is
photographed and (ii) observing environment information
comprising information regarding an illumination environment of a
place for observing an observation image of the object that is
output from an image output apparatus, and which then outputs the
30 acquired image.

71. (New) An image processing apparatus according to
claim 70, wherein the image data of the object taken by the image
input apparatus comprises a plurality of images of the object
taken by the image input apparatus.

72. (New) An image processing apparatus according to
claim 71, wherein the plurality of images of the object are
obtained by performing an image capturing operation of the image
input apparatus a plurality of times under respective conditions
5 which are different with respect to a position of the light
source with respect to the object.

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73. (New) An image processing apparatus according to claim 71, wherein the plurality of images of the object are obtained by performing an image capturing operation of the image input apparatus a plurality of times under respective conditions which are different with respect to relative positions of the image input apparatus and the object.

74. (New) An image processing apparatus according to claim 73, wherein the plurality of images of the object are obtained by performing the image capturing operation of the image input apparatus a plurality of times, while rotating the object with respect to the image input apparatus.

75. (New) An image processing apparatus according to claim 73, wherein the plurality of images of the object are obtained by performing an image capturing operation of the image input apparatus a plurality of times, while moving the image input apparatus with respect to the object.

76. (New) An image processing apparatus according to claim 70, further comprising an observing light form changing unit which converts the acquired image output from the observing light position changing unit into an image in which a form of the illuminating light for illuminating the object changed, by using

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the three-dimensional form information, the specular reflecting component and the image obtained by the interpolation and composition processing, based on the difference between the photographing environment information and the observing
10 environment information.

77. (New) An image processing apparatus according to claim 71, further comprising an observing light form changing unit which converts the acquired image output from the observing light position changing unit into an image in which a form of the
5 illuminating light for illuminating the object changed, by using the three-dimensional form information, the specular reflecting component and the image obtained by the interpolation and composition processing, based on the difference between the photographing environment information and the observing
10 environment information.

78. (New) An image processing apparatus according to claim 70, wherein the specular reflecting component separating unit further separates a diffusion reflecting component from the light reflected from the object in the image of the object and outputs the diffusion reflecting component.

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79. (New) An image processing apparatus according to claim 70, wherein the photographing environment information further comprises information regarding a color of the illuminating light for illuminating the object when the object is photographed, and the observing environment information further comprises information regarding a color of illuminating light for illuminating the place for observing the observation image of the object when the object is observed.

80. (New) An image processing apparatus according to claim 79, wherein (i) the information regarding the color of the illuminating light for illuminating the object when the image is photographed includes information indicating a spectrum of the illuminating light for illuminating the object, and (ii) the information regarding the color of the illuminating light for illuminating the place for observing the observation image of the object when the object is observed includes information indicating a spectrum of the illuminating light for illuminating the place.

81. (New) An image processing apparatus according to claim 70, wherein the image input apparatus comprises at least one of: at least one multi-spectrum camera, at least one digital still camera and at least one video camera.

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82. (New) An image processing apparatus for processing an image of an object, said apparatus comprising:

a three-dimensional form recognizing unit which recognizes a three-dimensional form of the object by using image data of the object taken by an image input apparatus, and which outputs object three-dimensional form information regarding the three-dimensional form of the object;

a specular reflecting component separating unit which separates a specular reflecting component from light reflected from the object in the image of the object, and which then outputs the specular reflecting component;

an interpolating and composing unit which subjects the image data of the object taken by the image input apparatus to interpolation and composition processing to thereby obtain an image of the object, and which then outputs the obtained image of the object; and

an observing light form changing unit which converts the image data of the object taken by the image input apparatus into an acquired image in which a form of illuminating light for illuminating the object changed, by using the three-dimensional form information, the specular reflecting component and the image obtained by the interpolation and composition processing, based on a difference between (i) photographing environment information comprising geometric information on a light source for

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25 illuminating the object when the object is photographed and
(ii) observing environment information comprising information
regarding an illumination environment of a place for observing an
observation image of the object that is output from an image
output apparatus, and which then outputs the acquired image.

83. (New) An image processing apparatus according to
claim 82, wherein the image data of the object taken by the image
input apparatus comprises a plurality of images of the object
taken by the image input apparatus.

84. (New) An image processing apparatus according to
claim 83, wherein the plurality of images of the object are
obtained by performing an image capturing operation of the image
input apparatus a plurality of times under respective conditions
5 which are different with respect to a position of the light
source with respect to the object.

85. (New) An image processing apparatus according to
claim 83, wherein the plurality of images of the object are
obtained by performing an image capturing operation of the image
input apparatus a plurality of times under respective conditions
5 which are different with respect to relative positions of the
image input apparatus and the object.

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86. (New) An image processing apparatus according to claim 85, wherein the plurality of images of the object are obtained by performing the image capturing operation of the image input apparatus a plurality of times, while rotating the object with respect to the image input apparatus.

87. (New) An image processing apparatus according to claim 85, wherein the plurality of images of the object are obtained by performing an image capturing operation of the image input apparatus a plurality of times, while moving the image input apparatus with respect to the object.

88. (New) An image processing apparatus according to claim 82, further comprising an observing light position changing unit which converts the image data of the object taken by the image input apparatus into image data in which the direction of the illuminating light for illuminating the object changed, by using the three-dimensional form information and the specular reflecting component, based on the difference between the photographing environment information and the observing environment information, and which outputs the image data to the observing light form changing unit.

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89. (New) An image processing apparatus according to claim 83, further comprising an observing light position changing unit which converts the image data of the object taken by the image input apparatus into image data in which the direction of the illuminating light for illuminating the object changed, by using the three-dimensional form information and the specular reflecting component, based on the difference between the photographing environment information and the observing environment information, and which outputs the image data to the observing light form changing unit.

90. (New) An image processing apparatus according to claim 82, wherein the specular reflecting component separating unit further separates a diffusion reflecting component from the light reflected from the object in the image of the object and outputs the diffusion reflecting component.

91. (New) An image processing apparatus according to claim 82, wherein the photographing environment information further comprises information regarding a color of the illuminating light for illuminating the object when the object is photographed, and the observing environment information further comprises information regarding a color of illuminating light for

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illuminating the place for observing the observation image of the object when the object is observed.

92. (New) An image processing apparatus according to claim 91, wherein (i) the information regarding the color of the illuminating light for illuminating the object when the image is photographed includes information indicating a spectrum of the illuminating light for illuminating the object, and (ii) the information regarding the color of the illuminating light for illuminating the place for observing the observation image of the object when the object is observed includes information indicating a spectrum of the illuminating light for illuminating the place.

93. (New) An image processing apparatus according to claim 82, wherein the image input apparatus comprises at least one of: at least one multi-spectrum camera, at least one digital still camera and at least one video camera.

94. (New) An image processing method for processing an image of an object, said method comprising:
recognizing a three-dimensional form information of the object by using image data of the object taken by an image input apparatus;

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separating a specular reflecting component from light reflected from the object in the image of the object, and then outputting the specular reflecting component;

10 subjecting the image data of the object taken by the image input apparatus to interpolation and composition processing to thereby obtain an image of the object, and then outputting the obtained image of the object;

15 determining a difference between inputted photographing environment information and inputted observing environment information, the photographing environment information comprising geometric information on a light source for illuminating the object when the object is photographed, and the observing environment information including information regarding an illumination environment of a place for observing an observation
20 image of the object that is output from an image output apparatus;

25 converting the image data of the object taken by the image input apparatus into an observation-light-position-changed image in which a direction of illuminating light for illuminating the object is changed, by using the three-dimensional form information, the specular reflecting component and the image obtained by the interpolation and composition processing, based on the difference between the photographing environment

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information and the observing environment information, and then
30 outputting the observation-light-position-changed image;
converting the observation-light-position-changed image into
an observation-light-form-changed image in which a form of the
illuminating light for illuminating the object is changed, by
using the three-dimensional form information, the specular
35 reflecting component and the image obtained by the interpolation
and composition processing, based on the difference between the
input photographing environment information and observing
environment information, and then outputting the observation-
light-form-changed image.